SUMMARY of EXPERIMENTAL DATA
4/19 - 4/22/93

Col.	1	2	3	4	5	6	7	8
Test No.	Gnd/ Flt	Dist mile	Rcvr	Freq kHz	Tlm.	SJC	FRC	Notes
SUN	AM							
1	F	-	A	-	on	0	<3	Telemeter system
2	F	-	A	-	off	0	0	interference tests
3	G	-	A	-	on	-	-	"
4	G	-	A	-	off	-	-	"
5	G	0	IFR	0				Interference Tx cal
SUN	PM							
6	G	3/4	A	2½	off	>10	>10	Ground based
7	G	3/4	A	5	off	0	0	interference vs.
8	G	1	A	2½	off	>10	0	distance tests
MON	AM							
9	F	-	A	-	on	0	2	calibration flight
10	F	-	A	-	off	0		"
11	F	-	A	-	on	0		"
12	F	1	A	+2½	on	800	0	data flight
13	F	1	A	-2½	on	16	149	"
14	F	1	A	+5	on	49	10	"
15	F	1	A	-5	on	0	0	"
MON	PM							
16	F	1	A	-7½	on	0	0	data flight
17	F	1	A	+7½	on	0	1	"
18	F	1	B	+0	on	60	126	procedure error
19	F	1	B	+5	on	16	43	data flight
TUES	AM							
20	G	3/4	ICOM	0				S=9+1db=-65dBm
21	G	2½	ICOM	0				S=4.1=-89dBm
22	G	2	ICOM	0				S=3.8-4.0=-90dBm
23	F	-	B	-	on	0	0	calibration flight
24	F	2½	B	-2½	on	48	2	data flight
25	F	2½	B	+2½	on	16	22	"
26	F	2½	B	+5	on	7	14	"
27	F	2½	B	-5	on	7	1	"
TUES	PM							
28	F	-	A	-	on	0	0	calibration flight
29	F	2½	A	-2½	on	9	3	data flight
30	F	2½	A	+2½	on	83	150	"
31	F	2½	A	+5	on	7	0	"
32	F	2½	A	-5	on	0	0	"
33	F	2½	C	-5	on	3	5	"
34	F	2½	C	+5	on	10	4	"
35	F	2½	C	+2½	on	45	72	"
36	F	2½	C	-2½	on	47	8	"

TABLE 1A

SUMMARY of EXPERIMENTAL DATA (cont)
4/19 - 4/22/93

Col.	1	2	3	4	5	6	7	8
Test No.	Gnd/ Flt	Dist mile	Rcvr	Freq kHz	Tlm.	SJC	FRC	Notes
WED	PM							
37	F	-	C	-	on	1	0	calibration flight
38	F	1½	C	+2½	on	181	803	data flight
39	F	1½	C	-2½	on	32	19	"
40	F	1½	C	-5	on	3	1	"
41	F	1½	C	+5	on	174	172	"
42	F	1½	B	+5	on	25	174	"
43	F	1½	B	+2½	on	38	103	"
44	F	1½	B	-2½	on	71	1	"
45	F	1½	B	-5	on	9	1	"
46	F	1½	A	-5	on	4	0	"
47	F	1½	A	-2½	on	385	159	"
48	F	1½	A	2½	on	133	219	"
49	F	1½	A	+5	on	142	15	"
50	G	1½	ICOM	0				S=6.5 @1W=-78dBm
51	G	1½	ICOM	0				S=1@100mw=-100dBm

TABLE 1A (cont)

Transcription of Recorded Comments on Telemeter Signal

Test No.	Recorded Comment
12	hits at 500 ft out
13	many hits
14	some hits
15	no hits
16	no hits
17	heard a hit
18	N/A - procedure error
19	heard some hits more than once on flight - rain may have invalidated test
23	no hits
24	no hits at extreme of range - hits heard on landing approach
25	hits heard at close range but none at extreme of range
26	hits at 200 feet out, more at half way out, none at extreme of range or on way back
27	no hits
28	no hits
29	hit half way out and again way out there
30	many hits: started when aircraft came overhead on way out
31	some hits on way out and on way back
32	no hits
33	false hit right after take off just prior to turning interference on, no hits after.
34	hits at extreme range
35	hits overhead, on the way out, and the way back
36	hits overhead, hits at 500 ft range, hits prior to turn, in turn, but no hits on the way back.
37	calibration flight
38	many hits. immediately, & often throughout flight
39	some hits immediately, on way out, but none on the way back
40	no hits
41	some hits on way out, more further out
42	many hits on way out, steady hits way out
43	many hits on way out, steady hits way out
44	heard some hits way out, but also on landing after interferer was turned off
45	no hits, but heard some hits after landing with interferer off
46	a few hits just before turn
47	hits overhead, hits at 1/2, & 3/4 way out, then steady hits. more in turn & on way back. Counts added in grass landing
48	hits overhead, hits at 500 ft, more hits on way out, steady hits at turn, more all the way back to overhead. Bad, bad.
49	some hits on way out, many hits at turn, more on way back

HITS are a telemetered indication of a FRC or SJC output

TABLE 1B

SUMMARY
INTERFERENCE TEST FLIGHT DATA

Col.	1	2	3	4	5	6
Test No.	Dist mile	Rcvr RUT	Freq kHz	SJC	FRC	Interference Evaluation
12	1	A	+2½	800	0	none
13	1	A	-2½	16	149	severe
14	1	A	+5	49	10	moderate
15	1	A	-5	0	0	none
16	1	A	-7½	0	0	none
17	1	A	+7½	0	1	none
19	1	B	+5	16	43	moderate
24	2½	B	-2½	48	2	minor
25	2½	B	+2½	16	22	moderate
26	2½	B	+5	7	14	moderate
27	2½	B	-5	7	1	none
29	2½	A	-2½	9	3	minor
30	2½	A	+2½	83	150	severe
31	2½	A	+5	7	0	none
32	2½	A	-5	0	0	none
33	2½	C	-5	3	5	none
34	2½	C	+5	10	4	minor
35	2½	C	+2½	45	72	severe
36	2½	C	-2½	47	8	minor
38	1½	C	+2½	181	803	severe
39	1½	C	-2½	32	19	moderate
40	1½	C	-5	3	1	none
41	1½	C	+5	174	172	severe
42	1½	B	+5	25	174	severe
43	1½	B	+2½	38	103	severe
44	1½	B	-2½	71	1	minor
45	1½	B	-5	9	1	none
46	1½	A	-5	4	0	none
47	1½	A	-2½	385	159	severe
48	1½	A	2½	133	219	severe
49	1½	A	+5	142	15	severe

TABLE 2

SORTED FLIGHT DATA

Primary Sort on Col. 6
Secondary Sort on Col. 1

Col.	1	2	3	4	5	6
Test No.	Dist mile	Rcvr	Freq kHz	SJC	FRC	Interference Evaluation
15	1	A	-5	0	0	none
16	1	A	-7½	0	0	none
17	1	A	+7½	0	1	none
46	1½	A	-5	4	0	none
45	1½	B	-5	9	1	none
40	1½	C	-5	3	1	none
31	2½	A	+5	7	0	none
32	2½	A	-5	0	0	none
27	2½	B	-5	7	1	none
33	2½	C	-5	3	5	none
12	1	A	+2½	800	0	minor
44	1½	B	-2½	71	1	minor
29	2½	A	-2½	9	3	minor
24	2½	B	-2½	48	2	minor
36	2½	C	-2½	47	8	minor
34	2½	C	+5	10	4	minor
14	1	A	+5	49	10	moderate
19	1	B	+5	16	43	moderate
39	1½	C	-2½	32	19	moderate
25	2½	B	+2½	16	22	moderate
26	2½	B	+5	7	14	moderate
13	1	A	-2½	16	149	severe
47	1½	A	-2½	385	159	severe
48	1½	A	+2½	133	219	severe
49	1½	A	+5	142	15	severe
42	1½	B	+5	25	174	severe
43	1½	B	+2½	38	103	severe
38	1½	C	+2½	181	803	severe
41	1½	C	+5	174	172	severe
30	2½	A	+2½	83	150	severe
35	2½	C	+2½	45	72	severe

TABLE 3

SORTED FLIGHT DATA

Primary Sort on Col. 1
Secondary Sort on Col. 6

Col.	1	2	3	4	5	6
Test No.	Dist mile	Rcvr	Freq kHz	SJC	FRC	Interference Evaluation
17	1	A	+7½	0	1	none
16	1	A	-7½	0	0	none
15	1	A	-5	0	0	none
12	1	A	+2½	800	0	minor
14	1	A	+5	49	10	moderate
19	1	B	+5	16	43	moderate
13	1	A	-2½	16	149	severe
46	1½	A	-5	4	0	none
45	1½	B	-5	9	1	none
40	1½	C	-5	3	1	none
44	1½	B	-2½	71	1	minor
39	1½	C	-2½	32	19	moderate
49	1½	A	+5	142	15	severe
42	1½	B	+5	25	174	severe
41	1½	C	+5	174	172	severe
48	1½	A	+2½	133	219	severe
43	1½	B	+2½	38	103	severe
38	1½	C	+2½	181	803	severe
47	1½	A	-2½	385	159	severe
31	2½	A	+5	7	0	none
32	2½	A	-5	0	0	none
27	2½	B	-5	7	1	none
33	2½	C	-5	3	5	none
34	2½	C	+5	10	4	minor
36	2½	C	-2½	47	8	minor
29	2½	A	-2½	9	3	minor
24	2½	B	-2½	48	2	minor
26	2½	B	+5	7	14	moderate
25	2½	B	+2½	16	22	moderate
30	2½	A	+2½	83	150	severe
35	2½	C	+2½	45	72	severe

TABLE 4

SORTED FLIGHT DATA

Primary Sort on Col. 6
Secondary Sort on Col. 2

Col.	1	2	3	4	5	6
Test No.	Dist mile	Rcvr	Freq kHz	SJC	FRC	Interference Evaluation
~~17~~	~~1~~	~~A~~	~~+7½~~	~~0~~	~~1~~	~~none~~
~~16~~	~~1~~	~~A~~	~~-7½~~	~~0~~	~~0~~	~~none~~
~~15~~	~~1~~	~~A~~	~~5~~	~~0~~	~~0~~	~~none~~
46	1½	A	-5	4	0	none
31	2½	A	+5	7	0	none
32	2½	A	-5	0	0	none
45	1½	B	-5	9	1	none
27	2½	B	-5	7	1	none
40	1½	C	-5	3	1	none
33	2½	C	-5	3	5	none
~~12~~	~~1~~	~~A~~	~~+2½~~	~~000~~	~~0~~	~~minor~~
29	2½	A	-2½	9	3	minor
44	1½	B	-2½	71	1	minor
24	2½	B	-2½	48	2	minor
36	2½	C	-2½	47	8	minor
34	2½	C	+5	10	4	minor
~~14~~	~~1~~	~~A~~	~~+5~~	~~49~~	~~10~~	~~moderate~~
~~19~~	~~1~~	~~B~~	~~+5~~	~~16~~	~~43~~	~~moderate~~
26	2½	B	+5	7	14	moderate
25	2½	B	+2½	16	22	moderate
39	1½	C	-2½	32	19	moderate
~~13~~	~~1~~	~~A~~	~~2½~~	~~16~~	~~149~~	~~severe~~
49	1½	A	+5	142	15	severe
48	1½	A	+2½	133	219	severe
47	1½	A	-2½	385	159	severe
30	2½	A	+2½	83	150	severe
42	1½	B	+5	25	174	severe
43	1½	B	+2½	38	103	severe
41	1½	C	+5	174	172	severe
38	1½	C	+2½	181	803	severe
35	2½	C	+2½	45	72	severe

TABLE 5

SORTED FLIGHT DATA

Primary Sort on Col. 3
Secondary Sort on Col. 6

Col.	1	2	3	4	5	6
Test No.	Dist mile	Rcvr	Freq kHz	SJC	FRC	Interference Evaluation
29	2½	A	-2½	9	3	minor
44	1½	B	-2½	71	1	minor
24	2½	B	-2½	48	2	minor
36	2½	C	-2½	47	8	moderate
39	1½	C	-2½	32	19	minor
13	1	A	-2½	16	149	severe
47	1½	A	-2½	385	159	severe
12	1	A	+2½	800	0	minor
25	2½	B	+2½	16	22	moderate
48	1½	A	+2½	133	219	severe
30	2½	A	+2½	83	150	severe
43	1½	B	+2½	38	103	severe
38	1½	C	+2½	181	803	severe
35	2½	C	+2½	45	72	severe
15	1	A	-5	0	0	none
46	1½	A	-5	4	0	none
32	2½	A	-5	0	0	none
45	1½	B	-5	9	1	none
27	2½	B	-5	7	1	none
40	1½	C	-5	3	1	none
33	2½	C	-5	3	5	none
31	2½	A	+5	7	0	none
34	2½	C	+5	10	4	minor
14	1	A	+5	49	10	moderate
19	1	B	+5	16	43	moderate
26	2½	B	+5	7	14	moderate
49	1½	A	+5	142	15	severe
42	1½	B	+5	25	174	severe
41	1½	C	+5	174	172	severe
16	1	A	-7½	0	0	none
17	1	A	+7½	0	1	none

TABLE 6

Mobile transmitter station

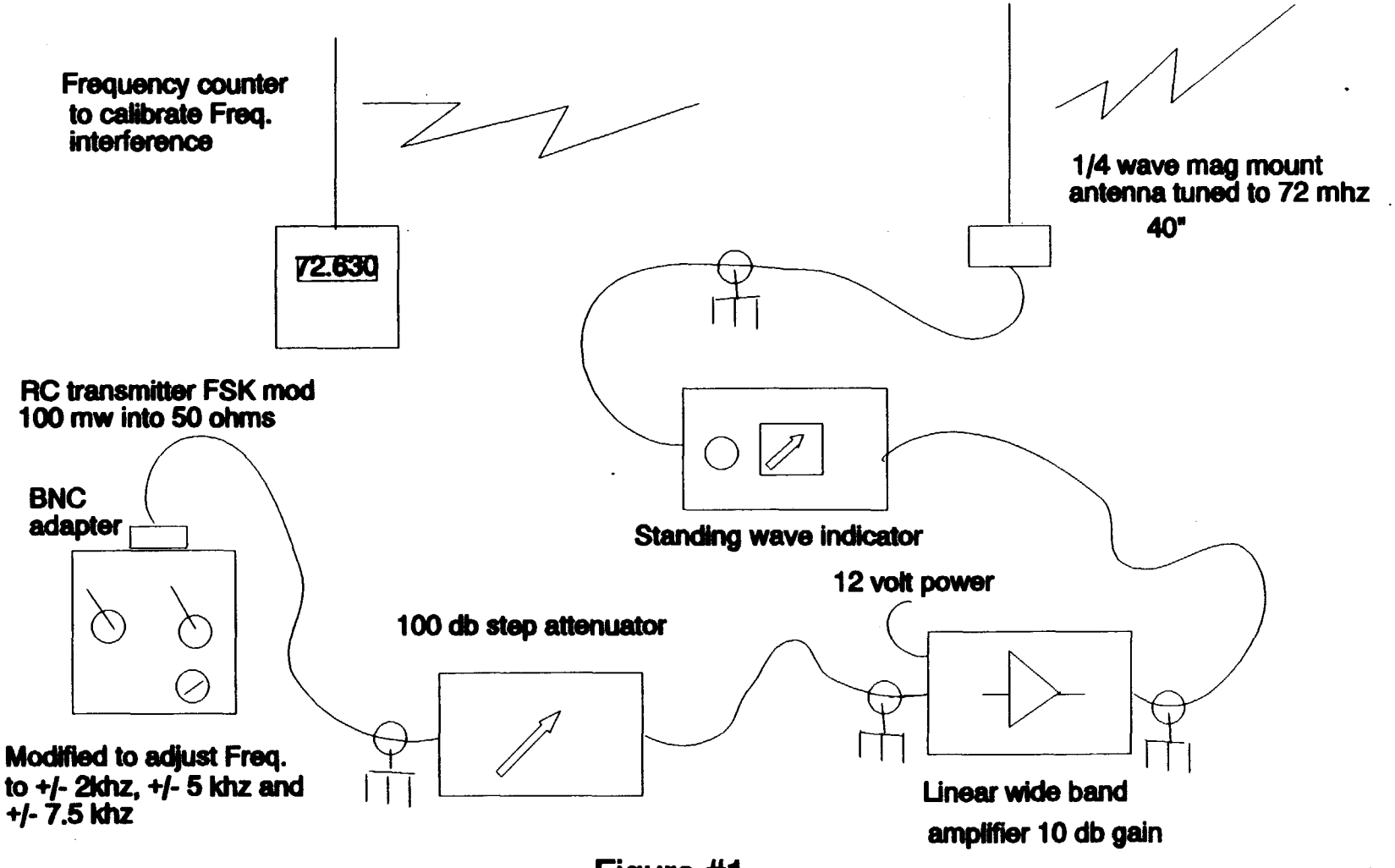
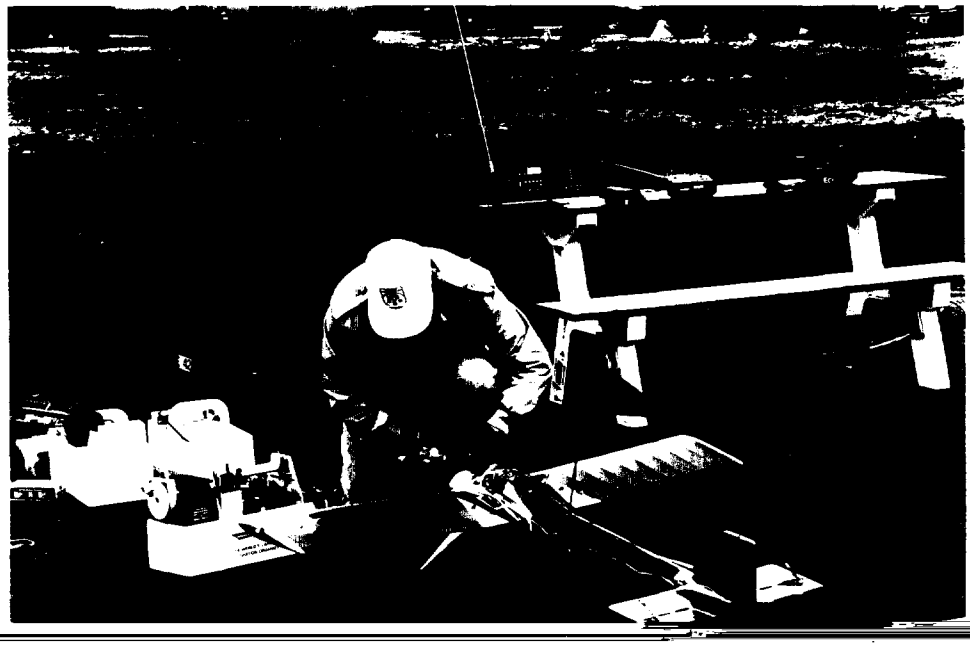


Figure #1



APPENDIX A

Interference Evaluation Criteria

It was impractical to evaluate how mobile transmissions affected model aircraft control by actually observing the aircraft's reaction to control signal interference. Instead, the aircraft was controlled by an RF link not subject to interference, and was used to carry the receiver-under-test that was subjected to mobile interference. The airborne interference was monitored remotely by a telemeter signal in addition to being recorded on board the model. The on-board aircraft data recorders provided a quantitative integrated value of the interference encountered during the flight. The telemeter signal provided qualitative information as to where in the flight path the interference was encountered.

For this report, the data taken was used to estimate how a model aircraft would aerodynamically respond to the interference encountered. Prior laboratory and flight tests provided an understanding of how to interpret the data. An instrumented R/C system was subjected to varying levels of interference in laboratory tests. The counters and telemetered signal were monitored and then used to relate servo response to the interference. This in turn, was correlated to an estimate of the aircraft's response to the servo response.

With no interference, the telemeter tone was steady, the LED displays did not count, and the servo position was fixed. With increasing levels of interference, the servo would oscillate slightly about it's commanded position, the servo jitter counter (SJC) would count intermittently, and the telemeter would *chirp* with each SJC count. The frame rate count (FRC) remained low. Short incidents of this type of response does not interfere with the aircraft's control, and is

Exhibit 2

VIDEOTAPE/TRANSCRIPT OF TESTING

AMA FLIGHT INTERFERENCE TESTS

TITLE GRAPHIC	Music
AMA LOGO ANIMATION	The Academy of Model Aeronautics is a scientific and educational association which promotes and protects the activities of model aviation.
AMA SIGN GRAPHIC: "NPRM 92-235"	AMA aviation and electronics experts from all over the country recently gathered to conduct scientific studies of the impact of FCC Notice of Proposed Rulemaking 92-235 on model aviation.
GRAPHIC: MUNCIE ON INDIANA MAP	Testing was conducted on the 18th through 22nd of April at the AMA's National Flying Site in Muncie, Indiana.
	Particpating in the tests were:
PICTURES (AS MENTIONED): "GEORGE STEINER"	George Steiner, Sacramento, California, Test Designer.
"WARREN PHLOUR"	Warren Phlour, Ann Arbor, Michigan, Telemetry System Designer.
"BILL HERSHBERGER"	Bill Hershberger, Annondale, Virginia, Test Bed Designer and Pilot.
"CHIP SMITH"	Chip Smith, Muncie, Indiana, Test Bed Ground Crew and Maintenance.
"DON LOWE"	AMA President Don Lowe, Alta Monte Springs, Florida, Observer and Backup Pilot.
TEAM LOOKING AT RECEIVERS ON BENCH	Operating under clearance granted by FCC Bureau Chief Ralph Haller, the AMA team set out to measure potential flight control interference.

PILOT FLYING R/C PLANE

Under proposed FCC regulations allowing spectrum usage within 2 1/2 KiloHertz of model aviation control frequencies, the team theorized that there would be significant interference with radio control flight systems.

WS TEST PLANE ON GROUND

MS TEST PLANE

To confirm this theory, a test bed aircraft was constructed to carry aloft an electronics package. This package measured missing control pulses and control servo chatter caused by interference on model aviation frequencies.

CU DOWNLINK TRANSMITTER

CU MISSING PULSE COUNTER
CU SERVO CHATTER COUNTER

A downlink transmitter relayed interference telemetry to a ground observer in real time, and on-board counters measured interference incidents for analysis after each flight.

CU TELEMETRY RECEIVER
ON BELT
CU ICOM RECEIVER
CU SPECTRUM ANALYZER
TEAM MEMBER USING HT

Ground instrumentation included a telemetry receiver, an ICOM receiver used to measure interfering signal strength, a spectrum analyzer, and ground communication radios.

TEST PLANE IN AIR
(PILOT WITH CONTROLLER?)

For safety purposes, actual control of the aircraft was moved to a frequency known to be unaffected by the test procedures.

INTERFERENCE SIGNAL GEAR

GEORGE "SWITCHING ON",
TALKING ON HT

A one-watt interference signal was generated on the ground, using calibrated equipment. For testing purposes this signal was generated at several different frequencies. Frequencies 2 1/2, 5, and 7 1/2 KiloHertz away from a model aircraft control frequency were measured for potential interference. Each frequency used was chosen because it falls within the proposed FCC rule changes.

TOPO MAP WITH AMA SITE 2 1/2 MI. CIRCLE	The test signal was generated at measured distances away from the test-bed aircraft. Interference from the test signal was measured at distances of 1/4 mi., 1/2 mi., 3/4 mi., 1 mi., 2 mi., and 2 1/2 mi.
CU WHEEL ODOMETER	
FLYING FOOTAGE	As the aircraft was flown from the National Flying Site main runway, the instrument packages recorded interference from the test signals at each distance, and observers on the ground made taped recordings of the proceedings which were later quantified and analyzed.
CU FLASHING COUNTER LIGHTS	The AMA team did measure interference from the test signals set up in accordance with proposed FCC rules.
DISTANCE/SIGNAL STRENGTH ANIMATION	Results indicate that interference with the control of model aircraft increases as interfering signals get closer to the control signal in both distance and frequency.
PILOT FLYING PLANE	The Academy of Model Aeronautics is concerned that

Attachment A

DOCUMENT OFF-LINE

This page has been substituted for one of the following:

o An oversize page or document (such as a map) which was too large to be scanned into the RIPS system.

o Microfilm, microform, certain photographs or videotape.

o Other materials which, for one reason or another, could not be scanned into the RIPS system.

The actual document, page(s) or materials may be reviewed by contacting an Information Technician. Please note the applicable docket or rulemaking number, document type and any other relevant information about the document in order to ensure speedy retrieval by the Information Technician.

Video Cassette labled as "Exhibit 2 A.M.A. R/C Flight Interference"